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A NEW SPECIES OF *SYNEMON* DOUBLEDAY (LEPIDOPTERA: CASTNIIDAE) FROM THE COLONA PLAINS, SOUTH AUSTRALIA

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Abstract

Synemon colona sp. n. is described from the Colona plains, Far West Coast District of South Australia. Adults are illustrated and compared with similar *Synemon* Doubleday species.

Introduction

The genus *Synemon* Doubleday, comprising day-flying sun-moths, presently contains 24 recognised species (Edwards 1996) and there are at least a further 22 unnamed or unstudied possible species, subspecies, morphs or forms (Douglas and Mariott 2003, Marriott 2003, Edwards 2006, CSIRO 2009 [a list of plesiotypes]). Most occur in the southern temperate habitats of the Australian mainland, comprising woodlands, mallee and heathlands, interspersed with grasslands, sedge-lands and rush-lands that contain the larval hostplants. The open grassland plains of the Colona pastoral region on the eastern Nullarbor Plain comprise such habitat, in which the spring flying *Synemon nais* Klug is a known faunal component (CSIRO 2009, Grund 2009). However, the Nullarbor Plain has been poorly surveyed for Lepidoptera during the autumn months. During a 2009 autumn survey of butterflies in the area, the author (Grund 2010) found a very small colony of undescribed sun-moths then comprising only females. The colony was again investigated during the autumn of 2011, when it was then found to comprise a large flight of newly emerged male and female adults; the author was also able to determine some of their early stage biology. It has subsequently been possible to show that these adults are closely related to members of the *Synemon collecta* morphological species-group (Douglas 2008) and it will be shown that they constitute a new species based on their morphology and biological attributes. Although the Castniidae group is presently under an extended review by E.D. Edwards (1996), the present author is not aware of any other accessible, similar *Synemon* species and therefore this paper is presented at this time to allow the information on this new species to be made available to other lepidopterists.

Abbreviations used are as follows: SAMA – South Australian Museum, Adelaide; ANIC – Australian National Insect Collection, Canberra; RG – collection of R. Grund.

Systematics

The author has examined original and subsequent photographic images and taxonomic descriptions of the three *Synemon* species currently included in the *S. collecta* species-group and agrees with the nomenclature conclusions of Edwards 1996. The three species and their synonyms are detailed below (after Edwards 1996).

Synemon collecta Swinhoe, C. 1892. (Type data; p 151, Pl VII fig 16. Holotype at Oxford University Museum (OUM) ♀, provenance 'North Australia'). Also documented in: Strand 1911; Edwards 1996, 2006; Douglas and Marriot 2003; Marriot 2003; Douglas 2008; Edwards and Ferguson 2009.

Synemon selene Klug, [J.C.F.] 1850. (Type data; p 249, figs 3, 4. Syntype[s] at Zoological Museum Berlin (ZMB) ♂ ♀, 'Adelaide [Region ex H. Behr Coll]'. Syntype images are also displayed in Douglas 2008). Boisduval 1875; Westwood 1877; Kirby 1892; Strand 1911; Edwards 1996, 2006; Douglas and Marriot 2003; Marriot 2003; Douglas 2008.

syn. ***Synemon adelaida*** Swinhoe, C. 1892. (Type data; p 154, Pl VII fig 10. Syntype[s] OUM ♂ ♀, 'Adelaide'). Strand 1911; Edwards 1996, 2006; Douglas 2008. (*S. adelaida* was synonymized under *S. selene* by Strand 1911, as first reviser).

Synemon theresa Doubleday, E. 1846. (Type data; p 517, Insects Pl 3 fig 6. Syntypes Natural History Museum London (BMNH), [Australia]). Angas 1847; Klug 1850; Walker 1854; Boisduval 1875; Butler 1877; Westwood 1877; Tepper 1882; Kirby 1892; Swinhoe 1892; Strand 1911; Edwards 1996; Douglas and Marriot 2003; Marriot 2003; Douglas 2008.

syn. ***Synemon mopsa*** Doubleday, E. 1846. (Type data; p 518, Insects Pl 3 fig 7. Syntype[s] BMNH, Australia [South Australia]). Klug 1850; Walker 1854; Boisduval 1875; Butler 1877; Westwood 1877; Tepper 1882; Kirby 1892; Swinhoe 1892; Strand 1911; Edwards 1996. (*S. theresa* and *S. mopsa* were published simultaneously by Doubleday. They were synonymized and priority given to *S. theresa* by Klug 1850 as first reviser; refer Edwards 1996).

syn. ***Synemon obscura*** Tepper, 1882. (Type data; p 35, Pl III fig 5. Syntype[s] lost, originally collected ~1866 at Lyndoch, South Australia [SA]). Kirby 1892; Strand 1911; Edwards 1996.

syn. ***Synemon livida*** Tepper, 1882. (Type data; p 35, Pl III fig 6. Syntype[s] ♀ lost, originally collected ~1866 at Lyndoch, SA). Kirby 1892; Strand 1911; Edwards 1996. (*S. obscura* and *S. livida* were synonymized with *S. theresa* by Edwards 1996, as first reviser).

Synemon colona **sp. n.**

(Figs 1-8, 18-23)

Types. Holotype ♂, SOUTH AUSTRALIA: labelled 'Colona, Yalata AL, SA, 21.iii.2011, R. Grund, RA2774 [DNA leg sample]' (in SAMA). *Paratypes* (Figs 3-8): labelled 'Colona, Yalata AL, SA, R. Grund'; 1♀, 24.iii.2009; 4♂, 1♀, 19.iii.2011; 5♂, 4♀, 20.iii.2011; 6♂, 3♀, 21.iii.2011 (in RG); 1♂, 20.iii.2011; 1♀, 24.iii.2009 (in ANIC).

Description. Body: head brown above; thorax and anterior two segments of abdomen dark brown-black above, remaining dorsal part of abdomen brown; thorax grey below; abdomen pale grey below with a paler transverse line at the segment joints; frons brown above, white below; head with large dorsal ocelli; labial palpi white scaled, very short, protruding about halfway across eye (viewed ventrally), ascending, apical segment short barrel shape, distal

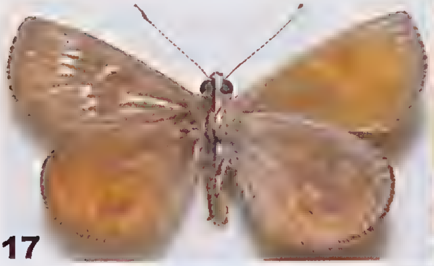
Figs 1-8. *Synemon colona* sp. n., upper and undersides: (1-2) holotype male (m) wing expanse 26 mm; (3) paratype (p) (m) dark form 26 mm; (4) paratype (p) (m) pale form 26 mm; (5-6) paratype (p) typical form (f) 26 mm; (7) paratype (p) (f) dark form 26 mm; (8) paratype (p) (f) pale form (worn) 26 mm.

end constricted; proboscis absent; eyes smooth, reflective eye pattern pale grey Type III when alive; antennae reach beyond the discal cell (dc) end or about 0.6 the length of the forewing (FW) costa, shaft scaled, dark brown black above, paler beneath becoming white near club, narrowly ringed white at each segment joint, club broad, mucronate, dark brown-black above, white below, mostly scaled but with a small black nudum area near tip underside (UNS); legs brown above, grey below, epiphysis present, tibial spurs 0,2,4. Wing venation: similar to *S. plana* Walker (Fig. 1, p 283 in Common 1990), but veins M, CuP and the small basal fork of 1A+2A (of the FW) are only partially developed; FW discal cell about 1/2 length of costa, distal end open between veins M1 and M2, bases of veins R1, R2, R3+R4+R5 originate from the discal cell, R4 and R5 stalked, bases of M1 and R3+R4+R5, and also bases of M2 and M3 nearly connate at discal cell; hindwing (HW) frenulum one-spined (male), distal end of discal cell open between veins M1 and M2, bases of M3 and CuA1 nearly connate at discal cell. Wing morphology: FW narrow, length 14 mm, upperside (UPS) background colour dark brown but brown scales become whitish basad causing a washed or speckling effect, margin narrow dark grey-brown edged basally with some white scaling, a large white discal cell-end spot of roughly equilateral triangular shape with one apex pointing towards the wing apex, a series of white arrowhead-shaped median spots pointing basad slightly offset distally with respect to the (dc) cell-end spot occur in spaces (cells) M3 to CuP but weakly developed in the latter, the white spot in space M3 becomes brownish distad and is confluent with the brownish white terminal spot, a series of white arrowhead-shaped postmedian spots pointing basad occur in spaces from M2 to near the costa, a series of brownish white rectangular shaped terminal spots occur next to the dark marginal line, becoming more elongate and more diffuse in the tornal zone from space M2, a wash of white scaling in cell spaces in basal half of wing from the (dc) to the inner margin, FW veining is conspicuously marked dark brown of variable intensity; HW UPS background colour is brown, the subbasal and inner margin area paler, the tornus area overlaid with orange scaling, margin narrow dark brown, a small obscure yellow-orange (dc) end spot, a broad diffuse postdiscal area of brownish yellow-orange colour in spaces M1 to CuA2 divided by diffuse dark brown veining, dark brown diffuse macular subterminal spots in spaces M1, M2, CuA1, CuA2, the latter two joined and the spot in CuA2 also divided by a thin longitudinal yellow-orange line, the spots in M1 and CuA2 may respectively be opened anteriorly or posteriorly to the background colour depending on glint; FW UNS background colour dark brown, paler basad, inner margin areas greyish (but overlain with orange scaling adjacent to HW margin), upperside postdiscal pale spots generally displayed beneath as diffuse (brownish) yellowish orange markings split by dark brown veining, in the FW the (dc) cell end spot is rectangular, the apical terminal spots are whitish, and the distal inner margin area is yellowish-orange; in the HW the postdiscal yellowish-orange area is very diffuse and dull, the macular spots larger, the terminal apex pale markings are whitish, the pale diffuse median spot in space M3 is confluent with the terminal spot, the dark veining conspicuously separates the pale terminal area into mostly rectangular spots; termens on both wings UPS and UNS are generally pale brown with a darker central area.

Figs 9-16. *Synemon* spp., upper and undersides. (9-13) *S. theresa*: (9) typical morphology (m) (broad FW) 34 mm Waterfall Gully (WG) SA 8.i.1997; (10) '*mopsa*' morphology (m) (narrow FW) 30 mm WG SA 23.i.1998; (11) typical form (f) 32 mm Morialta SA 23.i.2011; (12) pale form (f) 34 mm Morialta SA 23.i.2011; (13) dark form (f) 36 mm Stoneyfell SA 30.xii.1940. (14) *S. collecta* (f) SE Qld. Sept-Oct. (15-16) *S. selene*: (15) dark form similar to syntypes (m) 50 mm Two Wells SA 4.iii.1948; (16) pale form (f) 50 mm Two Wells SA 4.iii.1948.

Male genitalia (n = 4) (Figs 19-23). Of simple design. Tegumen smooth, short and broad viewed from above, sides compact touching the costa of the valves, top of tegumen has a gradual slope posteriorly to weakly fuse with uncus, latter short broad viewed from above, shallow from side, longer than tegumen, constricted next to tegumen, dorsal surface has gradual down-slope posteriorly, edges rolled over distally creating lateral bulges, then taper quickly to a blunt posterior point, uncus with long peripheral setae, the fultura superior is exposed in the area below the uncus and incorporates adjacent to each side of the anal tube a horizontal chitinous scaphial plate (gnathos or socii) that is not fixed to either the tegumen or uncus (gnathos complex), the plate has variable shape but is usually elongate wedge shape broadening posteriorly. Valve broad and simple from side view, almost square, all margins except the anterior side, thick and inrolled to the anellifer, anterior edge slightly concave posteriorly, the ventral margin (sacculus + harpe) is nearly straight, the dorsal anterior margin (costa) is initially angulate, then down-slopes posteriorly at a very shallow rate before slightly enlarging at the ampulla-cucullus area before it abruptly changes ventrally (with the cornice rounded) to a near-vertical sloped posterior margin, the ventral third of this margin then forms into a posteriorly directed short harpe (valvula) that tapers gradually inline with the sacculus margin ending in a short slightly upturned and sometimes slightly inturned (n = 1) pointed spine, some very long setae on the ampulla and sacculus margins. The vinculum is moderately wide and only sclerotized ventral of the tegumen, the dorsal hinge of the valva extends from the valva and attaches to the posterior margin of the vinculum, the anterior edge of the sclerotized vinculum slightly overlaps and merges with the apex angularis of the tegumen, the vinculum broadens at its base and in-coils posteriorly to form a bridge acting jointly as a ventral articulation point for the valves and a juxta support for the aedeagus. The aedeagus is short but large, massive, tubular of uniform thickness, curved downwards posteriorly, the dorso-posterior sclerotized edge slants at a shallow straight angle to a point ventrally, nearly reaching the posterior edge of the valve, the posterior vesica does not have obvious cornuti, the aedeagus enlarges considerably at its anterior end in the vertical plane ('phallobase' of Edwards *et al* 1999) with the dorsal part bulbous and the ventral coecum part only partially bulbous, the latter abuts into a specialised concave area of the saccus-vinculum, the proximal orifice opening is anterior or slightly ventro-due to the curve of the aedeagus; on the dorsal side of the prezonal aedeagus between the diaphragm and the bulbous enlargement is a large bulbous 'penile-cornutus' (Fig. 20) (on 3 specimens).

Figs 17-27. (17) *S. 'collecta'* (m) 36 mm, Shelley, Vic. 31.xii.1999. (18) eggs of *S. colona*, 4 and 5 ridged. (19-27) male genitalia, views. (19-23) *S. colona*: (19) lateral (specimen 1); (20) lateral (spec 2) (showing the 'penile-cornutus'); (21) ventral (spec 1); (22) dorsal (spec 1); (23) anterior (spec 1). (24-25) *S. theresa* lateral and ventral, WG, SA. (26) *S. 'collecta'* lateral, Shelley, Vic. (27) *S. selene* lateral, Two Wells, SA.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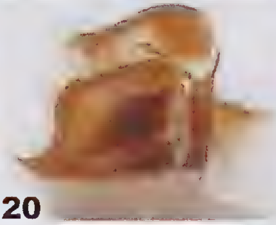
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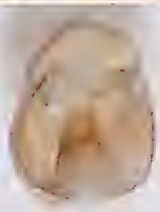
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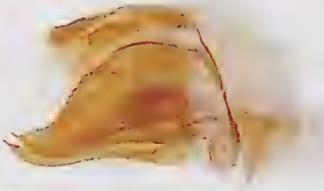
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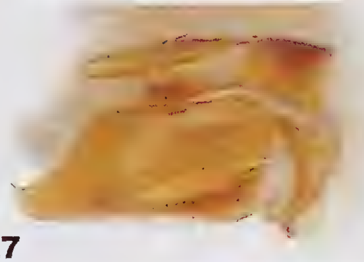
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Egg (n = 48, Fig. 18): Elongate ellipsoidal spindle shape (average 1.62 x 0.76 mm), with four (or sometimes five) prominent equi-spaced longitudinal ridges converging at each end of the egg (*e.g.* Fig. 10, Common and Edwards 1981). There are numerous (average 31), less prominent very fine transverse ridges or striae that form an interlocking disjunction at the longitudinal ridges (*e.g.* Fig. 2, Common and Edwards 1981). Each end of the egg constricts to a blunt point, one of which (usually the more pointed) contains the micropyle, the same end from which the larvae normally eclose. Eggs are laid singly on their sides, pale yellow when freshly laid, later turning white near eclosion, which occurred 40 days after oviposition. The ovipositor of the female is typically very long, and the distal end very bristly.

Etymology. Named after the historic homestead near the type locality.

Distribution. Presently known from only a small area of grassland near Colona Homestead on Yalata Aboriginal Land in the Far West Coast Region of South Australia (SA). The species was observed in flight on 23 March 2009 and again from 19-21 March 2011.

Hostplant. Eggs were laid on small stunted plants of *Austrostipa eremophila* and *A. scabra* (Poaceae).

Habitat. Found flying in broad-acre *Austrostipa eremophila* grasslands bounded by mallee *Eucalyptus* woodland. Other common grassland flora comprised *Austrostipa scabra*, *Austrodanthonia* spp. and *Lomandra effusa*.

Comments. Morphology of the males is highly variable, further compounded as they can occur in both dark and pale forms and consequently the degree of maculation and the intensity of colour can vary from one male to the next (Figs 3-4); the holotype is the ‘typical’ form. The brownish scaling on white areas can also be lost due to wear, which accentuates the white colour. Females have a morphology similar to males that is much paler and better defined and can also occur in both dark and pale forms (Figs 5-8).

Taxonomic diagnosis

Synemon colona is a small species (FW length ♂ 11-14 mm, ♀ 10-15 mm) having a very similar morphology to the adult *Synemon* species belonging to the *S. collecta* species-group, particularly in the FW UPS having the cryptic pattern of white striae on a dark brown background and a white spot at the end of the discal cell, as described more fully above. While the basic pattern layout for the species is stable, individual specimens are prone to variability, a trait seemingly afflicted on all species-group members. The latter are also defined by their primary larval hostplants being native grasses (Poaceae) belonging to the genera *Austrodanthonia* and *Austrostipa* (Edwards 2006, Douglas 2008). Adults do not have a functional proboscis for feeding. Species-group males also have a similar form of genitalia morphology, a feature often carried into other species of *Austrodanthonia-Austrostipa* feeding *Synemon*, such as *S. nais* and *S. plana*. However, the former differs from *S. colona* by the adults having a functional proboscis and the latter differs by having distinct morphological differences. (Good coloured photographic images of *S. nais*, *S. plana* and the *S. collecta* species-group can be found in Marriott 2003, Douglas 2008, CSIRO Entomology 2009 and Edwards and Ferguson 2009).

Morphological and extra trait differences between *S. colona* and other species-group members can be summarized as follows:

Synemon theresa (Figs 9-13) is closest to *S. colona* in wing morphology and also has very short labial palpi and no proboscis. However, it normally flies during the summer in SA, although there is a single Adelaide record for early March. The FW UPS in *S. theresa* has a slightly better developed veined pattern that is more complex than found in *S. colona*. In darker forms, the apical portion of the white postmedian band tends to be connected to the terminal pale area by pale scaling adjacent to the dark veins, producing a series of five dark, elongate, ocelli-like intra-spacial spots that are not clearly obvious in *S. colona*. The terminal white spots and the pale elongate area in space M3 of *S. colona* are not well developed in *S. theresa*. The discal cell-end white spot is conspicuously smaller in *S. theresa* and of quadrate shape rather than triangular, with the apical edge usually concave. There is a large, elongate, triangular dark mark in the discal cell immediately basad to the white cell-end spot that is only weakly developed along vein M in *S. colona*. The UNS pattern of *S. theresa* is comparable with *S. colona*, but in the latter the dark veining tends to be more obvious and the HW yellow-orange areas less developed. The pale elongate area in HW space M3 of *S. colona* is not well developed in *S. theresa*. The larva hostplants of *S. theresa* are primarily *Austrodanthonia*, whereas they are *Austrostipa* for *S. colona*.

In *S. theresa* there is also a propensity for the discal cell origin of FW veins R3+R4+R5 and M1, M2 and M3, and HW veins M3 and CuA1 to be noticeably separate, whereas in *S. colona* they tend to be connate. Males of *S. theresa* often have broad forewings (Fig. 9), which were not seen in *S. colona* males where all had narrow forewings. Although *S. colona* is compatible in size with *S. theresa*, it is on the smallest side of the latter's size range, (a phenomena also seen in the cryptically similar *S. discalis* Strand and *S. parthenoides* R. Felder). *Synemon theresa* currently has not been recorded any further west in SA than the east sides of St Vincent and Spencer Gulfs.

Synemon collecta (Figs 14, 17) and its complex-members comprise at least two documented members (Douglas 2008, Edwards and Ferguson 2009): (1), a pale-morph population from eastern Queensland (nominotypical) and warmer regions of northeastern NSW; and (2), a dark-morph population from Victoria and the cooler tableland areas of NSW (*S.* 'Armidale' of CSIRO 2009) that was treated as *S. collecta* by both Douglas (2008) and Edwards and Ferguson (2009). They collectively have a long flight season from spring to mid autumn, although in local populations the flight season is usually short

(CSIRO 2009). The FW UPS striate pattern of white markings of the complex-members is usually more prominent than in *S. colona* and the discal cell-end white spot is conspicuously narrow, often almost two-spotted, and slants across the discal cell-end at an angle that readily separates *S. collecta* complex-members from the other species-group members. The HW UNS in the females is yellow-orange and there is a clear series of black subterminal spots that readily separate them from *S. colona*. *Synemon collecta* is larger than *S. colona*, being nearly comparable with *S. selene* (the FW length of *S. collecta* is about 18-22 mm). *S. collecta* does not have a functional proboscis and the antennae club nudum is brown as in *S. selene*. The *S. collecta* complex currently has only been recorded from the eastern states of Australia. In this paper the 'Shelley' morph from Victoria (*S.* '*collecta*' in this paper) has been studied in preference to the nominotypical morph due to the more proximal location of the former in relation to *S. colona*.

Synemon selene (Figs 15-16) also flies in autumn but differs from *S. colona* by being twice the size of the latter (the FW length of *S. selene* is about 18-26 mm). In South Australian *S. selene*, the FW UPS band of pale terminal spots has its distal edge clearly scalloped rather than straight and postdiscal veining is always pale, rather than always dark as in *S. colona* and *S. theresa*. The elongated pale spot in FW space M3 is absent. *S. selene* has a rudimentary non-functional proboscis and the antennae club nudum is brown, rather than always black as in *S. colona* and *S. theresa*. *Synemon selene* currently has not been recorded any further west than the Adelaide Plains area in SA.

It is in the male genitalia (Figs 19-27) of the species-group members that apomorphic differences are noted. The chief apomorphy is the shape of the valva, which in *S. colona* is essentially 'square' in side view (Figs 19-20) but elongate in other species-group members (implying also a relatively longer aedeagus), with the dorsal margin gradually down-sloping posterior of the costa. The posterior end of the uncus is pointed in *S. colona* (Fig. 23) and *S. selene* but weakly divided in *S.* '*collecta*' and *S. theresa* (Fig. 25). A dorsal 'penile-cornutus' (Fig. 20) on the prezonal sheath is often seen in *S. colona* but is not seen in other species-group members. Other male genitalia differences from *S. colona* include: (1), in *S. theresa* (Figs 24-25) the tegumen and harpe are relatively narrow and longer, the angulate valva costa is more exaggerated and the vinculum is broader next to the dorsal hinge area of the valva, where the vinculum sends across the joining plate rather than the reverse as in *S. colona*; (2), in *S.* '*collecta*' the posterior ampulla margin of the valva is partially 'serrated' (Fig. 26), the costa is rounded rather than angular, the aedeagus tube constricts anteriorly, the enlarged parts of the 'phallobase' are not bulbous, the tegumen and scaphial plate are relatively much broader, the vinculum is narrow and is noticeably continuous anterior of the tegumen with no free apex angularis. (In nomino-typical *S. collecta* from southeastern Queensland, the posterior ampulla margin of the valva was not 'serrated' and there are some other minor genitalia differences between it and the Shelley morph, based on Edwards *et al.* 1999 and a poor SAMA male genitalia slide); (3), in *S. selene* (Fig. 27) the hyaline part of the fultura superior between the scaphial plate and the uncus-tegumen is very conspicuous, the uncus is noticeably elongated, the vinculum is very broad next to the dorsal valva hinge (*c.f. S. theresa*), the vinculum is strongly bent adjacent to the apex angularis, the aedeagus 'phallobase' is present but the dorsal enlargement is weak, while the ventral enlargement of the coecum is strongly bulbous ventrally, reaching down to abut the floor of the vinculum-saccus, where the latter acts as a juxta support for the aedeagus in lieu of the weaker juxta development of the posterior-coiled 'saccus' also present in this species.

The similarity of the male genitalia structure indicates that the four taxa studied belong in the same genus, while distinctive differences within the genitalia and other traits and morphologic attributes as defined above indicate that they have reached unique morpho-taxonomic species status.

Biology

The observed biology of *S. colona* will be collated into a separate paper at a later date.

Acknowledgments

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